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Art Unit 1754
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Listing of the Claims

1. (currently amended) A method of stabilizing nuclear material including one or more of: (a) the oxides or halides of actinides and/or transuranics (TRUs) ~~and/or~~, (b) hydrocarbons ~~and/or acids~~ contaminated with actinides and/or TRUs and (c) acids contaminated with actinide and/or TRUs, comprising treating the nuclear material by adjusting the pH of the nuclear material or any portion thereof to be not less than about 5 if required and adding sufficient MgO to convert fluorides present to MgF_2 and adding γ alumina in an amount sufficient to absorb substantially all hydrocarbon liquid present, adding a binder including MgO and KH_2PO_4 to the treated nuclear material to form a slurry, wherein the binder is present in an amount not less than about 20% by weight of the combination of nuclear material and binder, the MgO in the binder being present not less than 15% by weight of the combination nuclear material and binder, adding MgO in addition to the stoichiometric quantity necessary to react with the KH_2PO_4 in an amount up to about 45% by weight of the combined nuclear material and the binder depending on the make up of the nuclear material and the rate of reaction for the $MgKPO_4$ formed by reaction.

2. (original) The method of claim 1, wherein the actinides and/or TRUs contain uranium values.

3. (original) The method of claim 1, wherein the actinides and/or TRUs contain plutonium values.

4. (original) The method of claim 1, wherein the halides contain fluorides.

5. (original) The method of claim 1, wherein the hydrocarbons contain oils and/or

greases.

6. (original) The method of claim 1, wherein the nuclear material is a waste material.

7. (original) The method of claim 1, wherein the pH is adjusted prior to other treatment of the nuclear material.

8. (original) The method of claim 1, wherein a borate and/or boric acid is added during stabilization to control the rate of reaction.

9. (original) The method of claim 1, wherein a filler is added during stabilization.

10. (original) The method of claim 9, wherein the filler is a tetravalent metal oxide and/or alumina and/or class F fly ash.

11. (original) The method of claim 10, wherein the tetravalent metal oxide is one or more of titania or zirconia.

12. (original) The method of claim 1, wherein the pH is adjusted with MgO.

13. (original) The method of claim 1, wherein the MgO is calcined.

14. (original) The method of claim 1, wherein the liquid nuclear material has previously been treated with a stabilizer without a mixture of MgO and KH_2PO_4.

15. (currently amended) A method of stabilizing nuclear material including one or more of : (a) the oxides or halides of actinides and/or transuranics (TRUs) ~~and/or~~, (b) hydrocarbons ~~and/or acids~~ contaminated with actinides and/or TRUs, and (c) acids contaminated with actinide and/or TRUs, comprising treating the nuclear material by adjusting the pH of the liquid nuclear material or any portion thereof to be not less than about 5 with calcined MgO if required and adding sufficient calcined MgO to convert

fluorides present to MgF_2 and adding γ alumina in an amount sufficient to absorb substantially all hydrocarbon liquid present, adding a binder including calcined MgO and KH_2PO_4 to the treated liquid nuclear material to form a slurry, wherein the binder is present in the range of from about 60% to about 80% by weight of the combination of nuclear material and binder, the calcined MgO in the binder being present not less than 15% by weight of the combination nuclear material and binder, adding a borate or boric acid to control the rate of reaction and calcined MgO in addition to the stoichiometric quantity necessary to react with the KH_2PO_4 in an amount up to about 45% by weight of the combined nuclear material and the binder depending on the make up of the nuclear material and the rate of reaction for the $MgKPO_4$ formed by reaction.

16. (original) The method of claim 15, wherein the actinides and/or TRUs contain uranium and/or plutonium values.

17. (original) The method of claim 15, wherein the halides contain chlorides and/or fluorides.

18. (original) The method of claim 15, wherein the hydrocarbon liquid contains greases and/or oils.

19. (original) The method of claim 15, and further comprising adding a filler of alumina and/or a tetravalent metal oxide and/or class F fly ash.

20. (currently amended) A crystalline radioactive material comprising a binder of the reaction product of calcined MgO and KH_2PO_4, and a radioactive material of the oxides and/or halides of actinides and/or transuranics (TRUs) and/or acids contaminated with actinides and/or TRUs, and/or actinides and/or TRUs with or without oils and/or greases

treated prior to mixing with said binder to have a pH not less than about 5 and to convert fluorides present to MgF_2 with calcined MgO and to absorb liquid hydrocarbons present with γ alumina, wherein said radioactive material is encapsulated and stabilized by said binder, said binder being present in an amount not less than 20% by weight of the crystalline radioactive material.

21. (original) The crystalline radioactive material of claim 20, wherein said binder is present in the range of from about 60% to about 80% by weight thereof.

22. (original) The crystalline radioactive material of claim 21, wherein said actinides and/or TRUs contain uranium and/or plutonium values.

23. (original) The crystalline radioactive material of claim 22, wherein the pH is adjusted with calcined MgO.

24. (original) The crystalline radioactive material of claim 23, wherein the pH is not less than about 6.

25. (original) The crystalline radioactive material of claim 20, and further including up to about 2% by weight of the reaction products of a borate and/or boric acid and said binder.

26. (original) The crystalline radioactive material of claim 20, and further including a filler of one or more of alumina and/or a tetravalent metal oxide and/or class F fly ash.

27. (original) The crystalline radioactive material of claim 20, wherein the radioactive material contains chlorinated material mixed with actinide oxides.

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To make the waste forms very stable, a filler such as alumina (corundum) which is very stable up to 1800 ˚C. may be used. Alternatives to alumina are zirconia, titania, or any tetravalent metal oxides.

Very high loading of actinides or TRU oxides may be achieved in this ceramification. This may be as high as 80 wt.% without loss of integrity of the product, but generally loading in the range of from about 40% to about 80% by weight of the entire monolithic ceramic and waste is obtained.

To encapsulate fluorides, excess MgO is used to convert the fluoride solutions into MgF_2, which then becomes encapsulated in the magnesium potassium phosphate hexahydrate and becomes non-leachable.

To encapsulate liquid, semi-liquid and solid hydrocarbons such as solvents, greases, and oils, we have discovered identified a catalyst alpha or gamma alumina ~~(γ-alumina)~~ which absorbs hydrocarbon-containing liquids and gets encapsulated in the ceramic. Semi-liquid and solid organics do not get absorbed by λ or γ alumina, but do become encapsulated in the monolithic $MgKPO_4$.

To encapsulate acids, MgO, preferably calcined, is added to neutralize the acid and adjust the pH to >5 and KH_2PO_4 is added and stirred. Contaminants are encapsulated in the magnesium potassium phosphate hexhydrate and become non-leachable.

The basic Ceramicrete® binder consists of calcined magnesium oxide and monopotassium phosphate which when mixed with water forms a slurry that sets into a